Remarks/Arguments

Applicants have received and carefully reviewed the Office Action of the Examiner mailed April 16, 2008. Currently, claims 29-34, 36, 37, 39-45, 47-56, and 58-70 are pending. Claims 29-34, 36, 37, 39-45, 47-56, and 58-66 have been rejected.

Claim Rejections – 35 USC § 112

Claims 29-34, 36, 37, 39-56, and 58-66 were rejected under 35 U.S.C. 112, second paragraph, as failing to comply with the enablement requirement. More specifically, the Examiner states:

> One having ordinary skill in the art would not be enabled to create the fuel cells of the claimed invention having the membrane exposed by the apertures, wherein the parts of the membrane that are exposed are not covered by the catalyst, but where catalyst covers all other parts of the membrane (see Figure 4C of the instant invention). First, it is unclear how the reactants would split into hydrogen and oxygen ions, respectively, if the reactants provided through the apertures are not reacted at the catalyst. Second, it appears that the cells would short when the electrical connects are made without a load, as depicted in Figure 7.

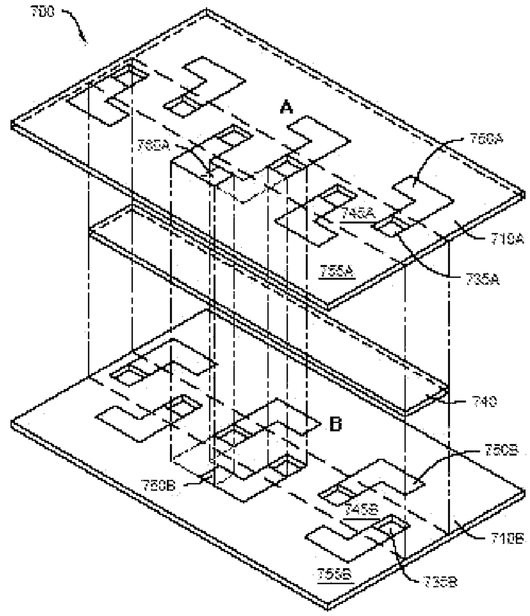
(see, Office Action, pages 4-5). The issues raised by the Examiner will be addressed in turn. First, the Examiner has characterized Figure 4C as depicting an embodiment "where the parts of the membrane that are exposed are not covered by the catalyst, but where the catalyst covers all other parts of the membrane". Applicants are puzzled by this interpretation of Fig. 4C and suspect that the Examiner may have incorrectly identified the components found in Fig. 4C as described at page 12 of the specification. The pertinent components shown in Fig. 4C, in order, are bottom surface (adjacent **414**) of electrode **410A**, <u>adhesive layer **420**</u>, proton exchange membrane **440** (including a top and bottom catalyst layer adjacent or included in the proton exchange membrane – see page 13, lines 1-3 and other discussion throughout the specification), <u>adhesive layer **420**</u>, and top surface (adjacent **412**) of electrode **410B**. It would appear that the Examiner may have erroneously assumed that <u>adhesive layers **420**</u> of Fig. 4C are interrupted <u>catalyst</u> layers.

In addition, and contrary to the Examiner's remarks, it should be noted that a catalyst layer is not strictly required for the operation of the cell. The Examiner is

reminded that a catalyst is substance that alters (usually increases) the rate at which a reaction occurs, usually by altering the activation energy. The reaction would proceed without a catalyst, albeit more slowly. Reactants provided to the fuel cell of the invention through the apertures would react at the surface of the proton exchange membrane by virtue of the difference in the chemical potential between the reactants and the products, with or without a catalyst, when a return path for the electrons is provided.

The second objection raised was "that the cells would short when the electrical connects are made without a load as depicted in Figure 7." This is not understood. With reference to Figure 7, it is noted that the only disclosed electrical connections between top electrode **710A** and bottom electrode **710B** are found in the regions of the respective conductive surface layers labeled as **760A** and **760B** (see dashed lines extending between **710A** and **710B**). As is clear from Figure 7 as well as Figure 4C and others, the conductive surface layers may be patterned on the top of layer **710A** and/or on the bottom of layer **710A**, depending on the configuration desired. The electrical connection shown explicitly at **760B** is described as electrically connecting "one micro fuel cell in series with another micro fuel cell" (see, instant specification, page 14, lines 17-18). As noted in the specification, "[s]imilar methods may be used to electrically connect micro fuel cells in parallel, and/or in series and in parallel, as desired" (see, instant specification, page 14, lines 18-19). As described, the cell is not short circuited.

Applicants suspect that the Examiner has failed to appreciate that possible connections between conductive regions (such as conductive regions 750A, 750B, 760A, 760B), which are located near each other are not necessarily made and that the specification in no way indicates that they are necessarily connected. In particular, there is no indication of a connection between tabs labeled "A" and "B", spaced apart by at least the thickness of the proton exchange membrane in the Figure 7 as modified below to identify the tabs in question.



Indeed, tab “A” may be patterned on the upper surface of **710A** and not available for direct connection with tab “B”. In fact, because Figure 7 does now show dashed lines extending between tab “A” and tab “B”, as is the case for region **760A** and **760B**, no electrical connection is shown in the illustrative embodiment. Figure 7 indicates one of many ways in which connections may be made between cells to achieve multi-cellular arrays which are connected, sometimes in a series and/or parallel arrangement, depending on the application.

Referring now specifically to paragraph (B) on page 4 of the Office Action, as discussed above there is no short circuit in Figure 7 as presented and discussed at page 14, lines 7-19 of the instant specification. With respect to paragraph (C) on page 4 of the Office Action, Examiner has essentially asserted, without support, that a chemical reaction between hydrogen and oxygen to form water does not occur without a catalyst. As discussed above, it would appear that the Examiner may have erroneously assumed that adhesive layers **420** of Fig. 4C are interrupted catalyst layers, which appears to be clear error. A catalyst, when used, may be included as part of the PEM 140, as acknowledged by the Examiner in the last two lines on page 2 of the Office Action. Also, while an appropriate catalyst will facilitate the reaction in question, the cell is expected to generate a potential between the electrodes even without a catalyst, which is contrary to the Examiner’s assertion. In such a configuration, the available current may

be lower than desired for some applications, but the fuel cell is clearly enabled. Enablement does not require optimization. Notably, dependent claim 30 recites that the proton exchange membrane includes a catalyst.

Accordingly, since the Examiner appears to have misconstrued the clear descriptions within the specification of two figures representing, correctly, illustrative functional embodiments of the claimed invention, Applicants respectfully request that the rejections under 35 U.S.C. 112, second paragraph, be withdrawn.

<u>Claim Rejections – 35 USC § 102</u>

Claims 29-30, 33-34, 36-48, 54, 56, and 60-66 were rejected under 35 U.S.C. 102(b) as anticipated by Pratt et al. (U.S. Patent No. 6,127,058), hereinafter Pratt. After careful review, Applicant must respectfully disagree. Claim 29 recites:

> 29. (Currently Amended) A method of forming a fuel cell, comprising the steps of:
>
> providing a first electrode layer having a first surface and a second opposing surface, wherein at least a portion of the first surface is conductive;
>
> forming a first aperture defined by a first aperture surface through the first electrode layer;
>
> providing a second electrode layer having a first surface and a second opposing surface, wherein at least a portion of the first surface is conductive;
>
> forming a second aperture defined by a second aperture surface through the second electrode layer;
>
> providing a proton exchange membrane having a first surface and a second opposing surface;
>
> providing ~~an~~ <u>a conductive</u> adhesive between the first electrode layer and the proton exchange membrane and between the second electrode layer and the proton exchange membrane;
>
> sandwiching the proton exchange membrane and the adhesive between the first electrode layer and the second electrode layer with the first and second apertures substantially free of the adhesive, where the first aperture of the first electrode layer is at least partially aligned with the second aperture of the second electrode layer, thereby exposing the proton exchange membrane, wherein the second surface of the first electrode layer is proximate the first surface of the proton exchange membrane and the first surface of the second electrode layer is proximate the second surface of the proton exchange membrane;

> providing an electrical connection between at least a portion of the first surface that is conductive of the first electrode layer and the proton exchange membrane; and
>
> providing an electrical connection between at least a portion of the first surface that is conductive of the second electrode layer and the proton exchange membrane.

While Applicants respectfully disagree with the Examiner's rejection, claim 29 has been amended to include the elements of dependent claim 46, and claim 46 has been canceled without prejudice.

Dependent claim 46 was not specifically addressed by the Examiner in the Office Action. However, on page 7 of the Office Action, and with respect to claims 36, 47, 64 and 65, the Examiner states:

> the adhesive layer discussed above must be conductive in order for the fuel cell to produce electricity, so it will be considered as a conductive layer. The layer would be provided after the apertures were formed in the current collecting layer (column 5 lines 9-13).

Thus, the rejection of claim 47, along with claims 36, 64, and 65, appears to rest upon an adhesive layer, not identified or characterized in Pratt except as an alternative to ultrasonic welding, being construed to be <u>conductive</u> and being located between the metal current collectors and the PEM. However, Pratt does not appear to have contemplated a conductive adhesive or to have taught that his structure employs a conductive adhesive or that such a hypothetical conductive adhesive would necessarily be positioned between the metal current collectors and either a PEM or a catalyst coating thereon. Instead Pratt appears to suggest only that in those fuel cell assemblies in which the plastic frame is replaced with a plastic film having metal current collectors, ultrasonic welding or the use of adhesives may be used to hold the cells together. Absent further teaching, this suggests that Pratt contemplated the use of ultrasonic welding or the use of adhesives only in those regions where they would replace the plastic frame, namely between the cells and around the perimeter. These locations within the six cell device of Pratt would not require the adhesive to be conductive, and in fact, may be detrimental by creating shorts between the six cells.

As can readily be seen, the Examiner's assertion that "the adhesive layer discussed above <u>must be conductive</u> in order for the fuel cell to produce electricity"

(emphasis added) is not supported by Pratt. The Examiner appears to be asserting that the adhesive mentioned in Pratt is inherently conductive. However, as noted in MPEP § 2163.07(a):

> To establish inherency, the extrinsic evidence "must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted) (emphasis added).

Clearly, and in view of the above remarks, it cannot readily be argued that the adhesive mentioned by Pratt is necessarily conductive, as asserted by the Examiner. For these and other reasons, claim 29 is believed to be clearly patentable over Pratt. For similar and other reasons, dependent claims 30-34, 36-37, 39-45, 61, and 69-70 are also believed to be clearly patentable over Pratt.

In addition, dependent claim 44 recites that the first electrode layer is substantially non-conductive, and includes one or more conductive through contacts. Pratt clearly does not teach such a configuration. The Examiner has analogized the plastic film of Figure 4 of Pratt with the non-conductive first electrode layer, and the current collectors as corresponding to the conductive layer. However, Pratt does not appear to teach "one or more conductive through contacts" through the plastic film of Figure 4. Pratt states that the current collectors are "etched in the metal foil", and that the holes in the plastic film "provide passage of fuel and oxidant to the electrode" (see, for example, Pratt, column 5, lines 19-22). Certainly it cannot readily be argued that the holes in the plastic film necessarily contain one or more conductive through contacts, as recited in claim 44. In fact, the Examiner acknowledged, in the §103(a) rejection discussed below, that Pratt teaches that "the contacts are only on one side of the non-conductive portion of the current collector". Since the current collector of Pratt is only on one side of the plastic film, there would appear to be no reason whatsoever to include conductive through contacts. For these additional reasons, dependent claim 44 is believed to be clearly patentable over Pratt. For similar and other reasons, dependent claim 45 is also believed to be clearly patentable over Pratt.

Now turning to independent claim 47, which recites:

> 47. (Currently Amended) A fuel cell comprising:
>
> a first electrode comprising:
>
> a non-conductive substrate, the non-conductive substrate having a first electrode top surface[[;]], a first electrode bottom surface[[;]], and a first electrode thickness defined by a first distance between the first electrode top surface and the first electrode bottom surface;
>
> a first electrode aperture through the first electrode thickness defined by a first electrode aperture surface;
>
> a second electrode comprising:
>
> a second electrode top surface;
>
> a second electrode bottom surface;
>
> a second electrode thickness defined by a second distance between the second electrode top surface and the second electrode bottom surface;
>
> a second electrode aperture through the second electrode thickness defined by a second electrode aperture surface;
>
> a first conductive layer provided on ~~including~~ at least a portion of the first electrode top surface, at least a portion of the first electrode bottom surface, and one or more of at least a portion of the first electrode aperture surface and a through contact, wherein the first conductive layer on the one or more of the at least a portion of the first electrode aperture surface and the through contact provides an electrical connection between the first conductive layer on the first electrode top surface and the first conductive layer on the first electrode bottom surface;
>
> a second conductive layer provided on ~~including~~ at least a portion of the second electrode top surface;
>
> a proton exchange membrane in electrical contact with and disposed between the first conductive layer and the second conductive layer;
>
> wherein, the first electrode aperture is at least partially aligned with the second electrode aperture, thereby exposing the proton exchange membrane.

As can be seen, claim 47 recites, among other things, a first electrode comprising: a non-conductive substrate, the non-conductive substrate having a first electrode top surface, a first electrode bottom surface, and a first electrode thickness defined by a first distance between the first electrode top surface and the first electrode bottom surface. Claim 47 further recites a first electrode aperture through the first electrode thickness defined by a first electrode aperture surface. Claim 47 also recites a first conductive layer provided on at least a portion of the first electrode top surface, at least a portion of the first electrode bottom surface, and one or more of at least a portion of the first electrode aperture surface

and a through contact, wherein the first conductive layer on the one or more of the at least a portion of the first electrode aperture surface and the through contact provides an electrical connection between the first conductive layer on the first electrode top surface and the first conductive layer on the first electrode bottom surface.

As noted above, the Examiner has analogized the plastic film of Figure 4 of Pratt with the non-conductive substrate, and the current collectors as corresponding to a conductive layer provided on the non-conductive substrate. However, Pratt does not appear to teach, disclose or suggest a first conductive layer provided on at least a portion of the first electrode top surface (e.g. of the plastic film), at least a portion of the first electrode bottom surface (e.g. of the plastic film), and one or more of at least a portion of the first electrode aperture surface and a through contact (e.g. through the plastic film), wherein the first conductive layer on the one or more of the at least a portion of the first electrode aperture surface and the through contact provides an electrical connection between the first conductive layer on the first electrode top surface and the first conductive layer on the first electrode bottom surface, as recited in claim 47. As can clearly be seen from Figure 4 of Pratt, the current collectors are only provided on <u>one side</u> of the plastic film. For these and other reasons, claim 47 is believed to be clearly patentable over Pratt. For similar and other reasons, dependent claim 48-53 and 68 are also believed to be clearly patentable over Pratt. For similar and other reasons, independent claims 54 and 63, and dependent claims 55-56, 58-60, 62, and 64-67 are also believed to be clearly patentable over Pratt.

<u>**Claim Rejections – 35 USC § 103**</u>

Claims 58 and 59 were rejected under 35 U.S.C. 103(a) as being unpatentable over Pratt (U.S. Patent No. 6,127,058) in view of Diekmann et al. (U.S. Patent No. 6,268,076). The Examiner acknowledges that Pratt fail to teach conductive feed-throughs through the first material, and further acknowledges that Pratt teach to provide contacts on <u>only</u> one side of the non-conduction portion of the current collector. However, the Examiner states that Diekmann et al. disclose a current collector having connections that are enveloped in conductive material (citing claim 12 of Diekmann et al). After careful review, Applicant must respectfully disagree.

As detailed above, independent claim 54 is believed to be clearly patentable over Pratt. Diekmann et al. do not appear to disclose what is missing from Pratt. For these and other reasons, dependent claims 58-59 are believed to be clearly patentable over Pratt in view of Diekmann et al.

In addition, Diekmann et al. do not appear to teach conductive feed-throughs through a substantially non-conducting material, as alleged by the Examiner. Instead, the current collector of Diekmann et al. appears to have a direct <u>one-sided</u> connection to one of the electrodes 4 of the fuel cell 5. More specifically, the current collector includes a base body 2, which appears to be conductive (ferrite alloy which contains chromium and aluminum, see Diekmann et al., column 2, lines 45-49). Contact elements 3 are shown electrically bonded to the base body 2, such as by means of weld surfacing (see Diekmann et al., column 4, lines 37-42). In Figure 1, the contact elements 3 are connected to electrode 4 of fuel cell 5 by means of a contact layer 7, in order to ensure an electrical connection with adequate electrical conductivity (see Diekmann et al., column 4, lines 42-46). Given this construction, it is not seen how Diekmann et al. disclose conductive feed-throughs through a substantially non-conductive material, as alleged by the Examiner. Notably, the cited portion of Diekmann et al. (e.g. claim 12) does not appear to teach anything different that the specification. For these and other reasons, dependent claims 58-59 are believed to be clearly patentable over Pratt in view of Diekmann et al. If the Examiner elects to maintain this rejection, Applicants respectfully request that the Examiner detail where each and every element of claims 58-59 is disclosed by Pratt in view of Diekmann et al., including a first length of <u>non-conductive</u> material.

Claim 55 was rejected under 35 U.S.C. 103(a) as being unpatentable over Pratt (U.S. Patent No. 6,127,058) in view of Simonton (U.S. Patent No. 4,906,536). As detailed above, independent claim 54 is believed to be clearly patentable over Pratt. Simonton does not appear to disclose what is missing from Pratt. For these and other reasons, dependent claim 55 is believed to be clearly patentable over Pratt in view of Simonton.

Claims 31 and 32 were rejected under 35 U.S.C. 103(a) as being unpatentable over Pratt (U.S. Patent No. 6,127,058) in view of Stanley et al. (U.S. Published Patent

Application No. 2004/0053100). As detailed above, independent claim 29 is believed to be clearly patentable over Pratt. Stanley et al. do not appear to disclose what is missing from Pratt. For these and other reasons, dependent claims 31-32 are also believed to be clearly patentable over Pratt in view of Stanley et al.

Claims 49-53 were rejected under 35 U.S.C. 103(a) as being unpatentable over Pratt (U.S. Patent No. 6,127,058) in view of Badding et al. (U.S. Published Patent Application No. 2002/0102450). As detailed above, independent claim 47 is believed to be clearly patentable over Pratt. Badding et al. do not appear to disclose what is missing from Pratt. For these and other reasons, dependent claims 48-53 are also believed to be clearly patentable over Pratt in view of Badding et al.

In view of the foregoing, all pending claims are believed to be in a condition for allowance. Reexamination and reconsideration are respectfully requested. If a telephone conference might be of assistance, please contact the undersigned attorney at (612) 359-9348.

Respectfully submitted:

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